

Amendment under Article 19(1)

Claims

[Claim 1] (Currently Amended)

5 A multinuclear rare earth complex formed by coordinating one or more types of molecules having a photosensitizing function and a vibrational energy quenching-suppressing function to a plurality of rare earth ions, which is represented by the general formula:

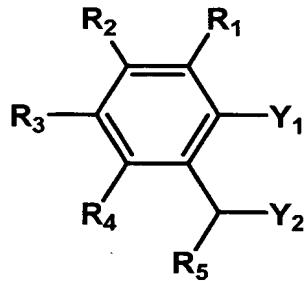
10 $L_p L'_q (Ln)_r X_s$,

wherein

L is a ligand having a photosensitizing function represented by the general formula:

[Chemical Formula 1]

15



wherein R_1 , R_2 , R_3 , R_4 and R_5 are independently hydrogen, a hydroxide group, a substituted or

20 unsubstituted amino group, a substituted or unsubstituted aryl group, a nitro group, a cyano group, an alkyl group or a cycloalkyl group represented by $-R$, an alkoxy group represented by $-OR$, or an acyl group represented by $-C(C=O)R$, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20;

Y₁ is -OH; and
Y₂ is =O;
p is an integer of 1 to 40;
L' is a ligand which is a hydroxide ion;
5 q is an integer of 0 to 8;
Ln is a rare earth ion;
r is an integer of 2 to 20, where a plurality of Ln may be different from each other;
X is O, -OH, S, -SH, Se or Te;
10 s is an integer of 1 to 20, where a plurality of X may be different from each other when s is an integer of 2 to 20; and further, the integers p, r and s have a relationship indicated by the expression:
[Expression 1]

15

$$1 \leq p/r \leq 4, \quad 1 \leq r/s \leq 4$$

wherein a coordination manner of L to Ln is: Coordination Manner (A) where both Y₁ and Y₂ bind to the identical Ln;
20 Coordination Manner (B) where Y₁ and Y₂ bind to different Ln each other; and a combination thereof, wherein when Y₁ coordinates to Ln, a proton leaves from -OH represented by Y₁ to form -O-, thereby L coordinates to Ln via -O-.

[Claim 2] (Cancelled)
25 [Claim 3] (Cancelled)
[Claim 4] (Currently Amended)

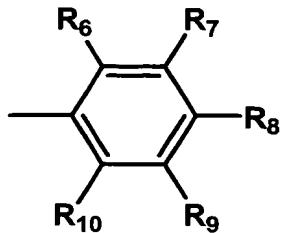
The multinuclear rare earth complex according to claim 1, wherein at least one of substituents R₁, R₂, R₃, R₄ and R₅ are an alkyl group or a cycloalkyl group
30 represented by -R, an alkoxy group represented by -OR or

an acyl group represented by $-C(=O)R$, where R is substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

[Claim 5]

5 The multinuclear rare earth complex according to claim 4, wherein R_5 is represented by the formula:

[Chemical Formula 2]



10

wherein R_6 , R_7 , R_8 , R_9 and R_{10} are independently hydrogen, a hydroxide group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, a nitro group, a cyano group, an alkyl group or a cycloalkyl group

15 represented by $-R$, an alkoxy group represented by $-OR$, or an acyl group represented by $-C(C=O)R$, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20, where at least one of R_1 , R_2 , R_3 , R_4 , R_6 , R_7 , R_8 , R_9 and R_{10} are an alkyl group or a cycloalkyl group represented by $-R$, an alkoxy group represented by $-OR$, or an acyl group represented by $-C(C=O)R$, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

20 [Claim 6]

The multinuclear rare earth complex according to claim 4, wherein R_5 is an alkyl group or a cycloalkyl

group represented by -R, an alkoxy group represented by -OR, or an acyl group represented by -C(C=O)R, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

5 [Claim 7]

The multinuclear rare earth complex according to claim 5 or 6, wherein R is a substituted or unsubstituted alkyl group having a carbon number of 6 to 12.

10 [Claim 8]

The multinuclear rare earth complex according to claim 7, wherein R is a substituted or unsubstituted alkyl group having a carbon number of 8 to 12.

[Claim 9]

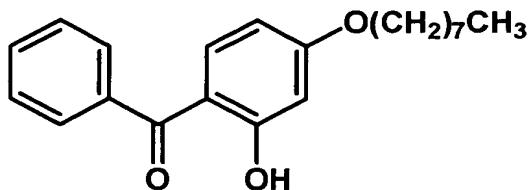
15 The multinuclear rare earth complex according to claim 1, wherein the rare earth ion is an ion of lanthanide selected from a group consisting of europium (Eu), terbium (Tb), neodymium (Nd), samarium (Sm), erbium (Er) and ytterbium (Yb) or a combination thereof.

20 [Claim 10]

The multinuclear rare earth complex according to claim 5, which is represented by the general formula: $L_{10}(Ln)_4X$,
wherein

25 L is a ligand represented by the formula:

[Chemical Formula 3]



Ln is europium (Eu) ion; and

X is o, and which has the following properties:

Elementary Analysis: as C₂₁₀H₂₅₀O₃₁Eu₄,

Theoretical values C, 65.04%; H, 6.50%; Eu, 15.67%

5 Observed values C, 64.90%; H, 6.39%; Eu, 15.41%

IR (KBr, cm⁻¹): (ν_{CH}) 2922, (ν_{C=C}) 1596, (ν_{Ph-O}) 1243

¹H-NMR (CDCl₃): δ12.7 (1H, s), δ7.6-7.2 (3H, m), δ6.5-6.4 (5H, d), δ4.0 (2H, t), δ1.8 (2H, m), δ0.9 (3H, t)

FAB-MS : m/z 3552.1 [Eu₄(L⁻)₉O²⁻]⁺.

10 [Claim 11]

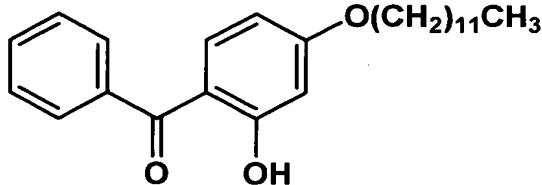
The multinuclear rare earth complex according to claim 5, which is represented by the general formula:

L₁₀(Ln)₄X,

wherein

15 L is a ligand represented by the formula:

[Chemical Formula 4]



Ln is europium (Eu) ion; and

X is o, and which has the following properties:

20 Elementary Analysis: as C₂₅₀H₃₃₀O₃₁Eu₄,

Theoretical values C, 67.64%; H, 7.49%; Eu, 13.69%

Observed values C, 67.50%; H, 7.45%; Eu, 13.49%

IR (KBr, cm⁻¹): (ν_{CH}) 2924, (ν_{C=C}) 1608, (ν_{Ph-O}) 1247

¹H-NMR (CDCl₃): δ12.7 (1H, s), δ7.6-7.3 (3H, m), δ6.5-6.4 (5H, d),

25 δ4.0 (2H, t), δ1.8 (2H, m), δ0.9 (3H, t)

FAB-MS: m/z 4055.9 [Eu₄(L⁻)₉O²⁻]⁺.

[Claim 12]

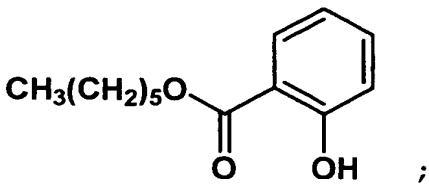
The multinuclear rare earth complex according to claim 6, which is represented by the general formula:

5 L₁₆ L'₈ (Ln)₉X₂,

wherein

L is a ligand represented by the formula:

[Chemical Formula 5]



10 L' is OH⁻;

Ln is terbium (Tb) ion; and

X is o, and which has the following properties:

Elementary Analysis: as C₂₁₄H₃₂₄O₇₂NTb₉,

Theoretical values C, 46.79%; H, 5.93%; Tb, 26.46%

15 Observed values C, 46.72%; H, 5.18%; Tb, 26.04%

IR (KBr, cm⁻¹): (ν_{CH}) 2957, 2931, (ν_{C=O}) 1674, 1637, (ν_{C=C}) 1598, (ν_{Ph-O}) 1243

¹H-NMR (CDCl₃): δ10.9 (1H), δ7.9-6.9 (4H), δ4.3 (2H), δ1.8 (2H), δ1.4 (6H), δ0.9 (3H)

20 FAB-MS: m/z 5140.2 [Tb₉(L⁻)₁₆(O²⁻)₂(OH⁻)₈+2H⁺]⁺.

[Claim 13] (Currently Amended)

A fluorescent substance containing the multinuclear rare earth complex according to any one of claims 1, and 4 to 12.

25 [Claim 14]

A resin formed materials made by compounding the fluorescent substance according to claim 13.